PASTORAL UTILIZATION AND LAND COVER CHANGE: A CASE STUDY FROM THE SANQEBETHU VALLEY, EASTERN LESOTHO

With 5 figures, 3 tables, 4 photos and 1 Supplement (III – Fig. 2)

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Zusammenfassung: Weidenutzung und Landschaftsveränderungen: Ein Fallbeispiel aus dem Sanqebethu-Tal im östlichen Lesotho

Seit der Kolonialzeit gilt das Königreich Lesotho als ein bekanntes Beispiel für weitflächige Landdegradation. Als Folge anhaltend hoher Nutzungsintensität, vornehmlich in Form von Beweidung, Brand des Graslandes und Sammlung von Brennholz, werden die agraren Ressourcenpotenziale während der vergangenen Jahrzehnte mit verstärkter Bodenerosion und massiver Degradation der Weideflächen konfrontiert. Am Beispiel des Sanqebethu-Tales im östlichen Hochland von Lesotho (Mokhotlong Distrikt) behandelt dieser Beitrag die jüngere Entwicklung von Ressourcennutzungsmustern und weidewirtschaftlicher Nutzungsintensität sowie die daraus resultierenden Vegetations- und Landschaftsveränderungen. Gestützt auf aktuelle Feldbefunde, Vergleichsdaten des Jahres 1988 und eine multitemporale Analyse von Satellitendaten des Sensors Landsat TM werden die Situationen in den Jahren 1988/89 und 1999 gegenübergestellt und vergleichend interpretiert. Trotz eines deutlichen Rückgangs der Weidenutzung zwischen diesen beiden Zeitschnitten zeigt sich eine leichte Abnahme der Vegetationsbedeckung im Bereich des Höhengraslandes. Die Ergebnisse werden vor dem Hintergrund aktueller weideökologischer und theoretischer Konzepte diskutiert.

Summary: Since colonial times, the mountain kingdom of Lesotho has served as a prominent example for widespread land degradation. Over the last decades, land use has been confronted with accelerated soil erosion, turf loss and grassland degradation as a result of a generally high and continuous anthropo-zoogenic impact, e.g. grazing, grassland burning and fuelwood collection. Based on a comparative approach, this paper analyses recent developments of pastoral resource utilization and subsequent vegetation change in the Sanqebethu Valley, situated in the eastern highlands of Lesotho (Mokhotlong District). The assessment of contemporary land use and land cover change is based on a time series of remote sensing data (Landsat TM) from 1989 and 1999, a recent ground survey and comparative data from 1988. High altitude grasslands show a slight reduction of vegetation cover, although the general intensity of pastoral utilization decreased significantly in the interim decade. The results are discussed with regard to recent pasture-ecological and theoretical concepts.

1 Introduction and objectives

Management systems and changes in the intensity of pastoral utilization are widely recognized as key issues of integrated and applied research on African rangelands. The contemporary debate focuses on topics such as sustainability of indigenous range management strategies, legitimacy of transhumance, and ecological outcomes such as land cover change and environmental degradation. Classic concepts, based on assumptions of stability and equilibrium of ecological carrying capacity, have provided the standard by which many rangelands are considered overstocked and deteriorated. This conventional view stresses the destructive potential of mobile livestock keeping and the need for control of animal numbers and herd movements. Especially in the case of rangelands managed under traditional common property regimes, land mismanagement and subsequent land degradation are typically attributed to pastoralism. The theoretical framework is based on the 'tragedy of the commons' paradigm (HARDIN 1968), which serves as an underlying key model to describe resource degradation as a consequence of many individuals using scarce resources in common.

A number of recent studies (e.g. SCOONES 1995; LEACH a. MEARNS 1996; NIAMIR-FULLER 1999) challenge these core conjectures for the semiarid rangelands and thus give way to a 'new paradigm' in the assessment of pastoral development in Africa. Production potentials of semiarid rangelands are generally characterized by non-equilibrium dynamic patterns (BEHNKE a. SCOONES 1993; BEHNKE a. ABEL 1996) due to high levels of inter-annual variability of precipitation with frequent droughts and other unpredictable factors. Therefore, prognostic scenarios and explanations of calamities primarily based on concepts of ecological carrying capacity are often insufficient. Apparently, most classic approaches tend to neglect issues such as indigenous knowledge in range management and do not recognize the necessities and particularities of livelihood strategies under conditions of uncertainty (e.g. PERRIER 1995; SANDFORD 1995; SCOONES 1996). More recent approaches on 'governing the commons' (OSTROM 1990) put particular emphasis on understand-

ing indigenous rules and regulations in the management of common property regimes.

As uncertainties prevail about the extent of environmental degradation and the role of local communities in fostering landscape changes, integrated case studies are required to identify and account for the frequency and magnitude of land use and land cover change.[1)]

The small and land-locked mountain kingdom of Lesotho (30,355 km^2), formerly the British protectorate of Basutoland (1884–1966)[2)], is regarded as a prominent example of widespread environmental degradation. The decreasing agrarian production potential and degradation of cultivated areas and pastures is indicated by accelerated soil erosion and turf loss. Annual loss of arable land is estimated to reach an area of 1,000 hectares (GAY et al. 1995, 51). According to this figure the arable land of Lesotho shrank from 9% to 8% of the total area between 1994 and 2001. Taking into account the recent population growth of 2.6% per year (CHAKELA 1999, 206), population density of Lesotho had increased to 800 people per hectare of arable land in 1997. Continuous pressure on the agrarian resources and rapid expansion of settlements during the past century challenge developmental perspectives of land use systems and raise questions about contemporary land cover change and sustainability.

The high altitude vegetation of Lesotho is one of the country's most valuable resources for the subsistence of the local population and a key issue for the regional hydrology of the mountain catchments (GROBBELAAR a. STEGMANN 1987; MORRIS a. GRAB 1997). A better understanding of resource management systems and land cover change requires an integrated research perspective, which takes into account issues such as environmental conditions, natural hazards, regional livelihood strategies and external influences (NÜSSER 2000; GRAB a. NÜSSER 2001).

The present study comprises an assessment of contemporary changes in pastoral utilization and corresponding changes of vegetation status and land cover in the catchment area of the upper Sanqebethu River (Mokhotlong District, eastern Lesotho). The focus is on the situation and conditions in 1988/89 and 1999. The upper Sanqebethu Valley is selected as a case study region in order to reassess sites which have been studied in 1988 within the South African 'Drakensberg/Maluti Mountain Catchment Conservation Programme' (MORRIS et al. 1989; QUINLAN 1989; BAINBRIDGE et al. 1991).[3)] Especially the detailed grazing inventories carried out by QUINLAN (1989) and by the Range Management Division of Lesotho (1991) serve as a valuable database for comparative studies. The primary goal of recent fieldwork is to provide detailed information on the intensity and development of pastoral utilization (livestock units, stocking densities), the distribution and functional differentiation of grazing posts (location, utilization period) and the pastoral migration patterns (seasonal mobility, daily grazing). The intensities of pastoral utilization during the summers and winters of 1999 are investigated, mapped and quantified in order to collate them with respective data from 1988. Furthermore, comparative analyses of matched satellite imagery from 1989 and 1999 enable correlations between pastoral utilization and land cover change to be made.

2 Study area: location, accessibility and environmental setting

The undulating mountain plateau of eastern Lesotho is bounded by the rugged barrier of the High Drakensberg, the most prominent part of the Great Escarpment. This continental watershed also marks the boundary between Lesotho and KwaZulu/Natal, a province of the Republic of South Africa (Fig. 1). Comprising the easternmost part of the Lesotho highlands, the study area extends between 29°15'–29°22'S and 29°15'–29°27'E. It encompasses the uppermost villages and cultivated areas of the Sanqebethu Valley with its upper tributaries Jareteng, Langa-le-balele, Mahlabachana, Merareng and Moiteling to the east, and the uppermost Mokhotlong Valley to the south-east. The topography of the region is markedly mountainous, encompassing ranges that reach elevations above 3300 m, and the deeply incised Sanqebethu Valley between 2400 and 2750 m (Photo 1). At the south-eastern edge of the study area, Giant's Castle (3314 m) separates the north-east-facing portion (Northern Berg) of the High Drakensberg, from its south-east-facing part (Southern Berg).

[1)] The international LUCC programme (Land Use and Land Cover Change) studies causes, patterns and rates of land use change and subsequent landscape transformation (e.g. TURNER et al. 1994; TURNER 1997; LAMBIN et al. 1999). Apparently, the analysis of these issues needs to integrate specific aspects of the regional socio-economic, cultural and political context (GEIST 1999; EHLERS 2000).

[2)] The indigenous people of Lesotho call themselves Basotho.

[3)] This multi-disciplinary research and resource planning project was co-ordinated by the Natal Parks Board (since 1998 KwaZulu/Natal Nature Conservation Service) in South Africa and the Range Management Division, Ministry of Agriculture in Lesotho.

Sources: Lesotho Government (1994): Map of Lesotho 1: 250 000; Mafakane (1999): Lesotho Roads Network

Draft: M. Nüsser; Cartographie: G. Bräuer-Jux, M. Nüsser

Fig.1: Map of Lesotho
Karte von Lesotho

Towards South Africa, the Giant's Castle Game Reserve (34,638 ha), one of the provinces' oldest nature reserves (proclaimed in 1907) within the present uKhahlamba Drakensberg Park (250,000 ha) adjoins the study area to the east. The accessibility of Sanqebethu Valley from Mokhotlong Town, the central place of eastern Lesotho has been improved after the opening up for four-wheel drive vehicles in 1975. Presently the track goes up to the village of Koeneng (2530 m), whereas the upper tributaries of the study area can be reached on horseback or foot only. Steep footpaths cross the Bannermann's and Langa-le-balele passes on the South African border (Fig. 2 – Suppl. III).[4)]

Mean annual precipitation decreases from c. 1600 mm at the escarpment edge[5)] to 575 mm at Mokhot-

[4)] These illegal routes are frequently used for smuggling of *Dagga* (*Cannabis sativa*) to South Africa.

[5)] Data from the Cathedral Peak area after KILLICK (1963, 17).

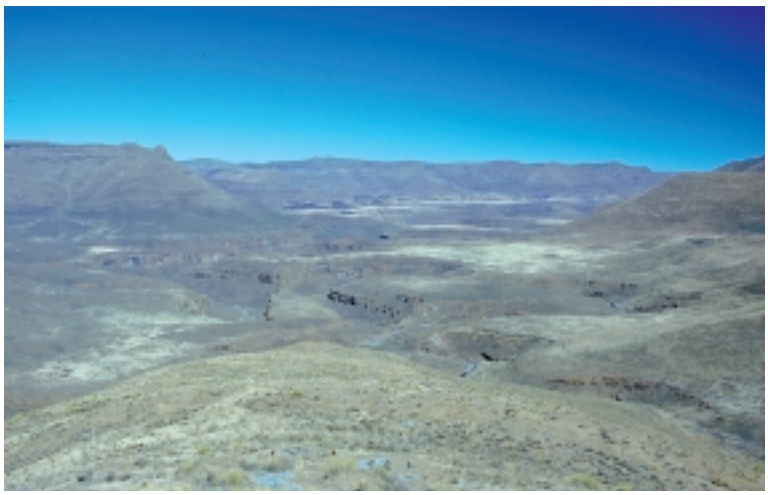


Photo 1: Upper Sanqebethu Valley. The photograph shows the deeply incised Sanqebethu River, a major tributary of the Mokhotlong River, and the surrounding slopes reaching altitudes above 3300 m. The ploughed fields of the uppermost villages Ntsirele and Koeneng are visible in the background. Photograph taken from 2920 m, View towards Southwest (M. NÜSSER, 15.8.1999)

Das obere Sanqebethu-Tal. Das Photo zeigt den tief eingeschnittenen Sanqebethu-Fluss, einen Haupttributär des Mokhotlong-Flusses sowie die umgebenden Hänge, die Höhen über 3300 m erreichen. Das gepflügte Kulturland der höchstgelegenen Dörfer Ntsirele und Koeneng ist im Hintergrund erkennbar. Standort: 2920 m, Blick nach Südwesten (15.8.1999)

long Town (2377 m), located in the rain shadow of the High Drakensberg, about 35 km to the west (KILLICK 1978a, 571). Besides this steep spatial gradient, annual distribution of humidity is strongly seasonal. Almost 80% of the total precipitation falls between October and March (KILLICK 1978a, 567) resulting in a humid vegetation period. Frequent thunderstorms and recurrent periods of fog contribute to the general humidity during summer. Winter conditions are characterized by a long frost period with extended droughts. Absolute minimum temperature drops to below –20 °C at the highest altitudes. Usually restricted to the summits and ridges in the proximity of the escarpment, snow falls frequently between April and September but rarely results in a longer lasting cover (MULDER a. GRAB in press). However, snow cover may last for several weeks in exceptional years (e.g. in 1964, 1987 and 1996). Differences exist between north and south-facing slopes because of distinct solar radiation patterns (GRANGER a. SCHULZE 1977). Apparently, the resulting ecological differences, such as snow cover duration and moisture conditions between the warmer and drier north-facing slopes and the colder and moister south-facing slopes are important for the distribution of vegetation types.

The vegetation of the summit plateau between approximately 2750 m and the highest peaks comprises grassland, dwarf-scrub, wetland, and open scree and rock communities. Basalt outcrops are colonized by scattered patches of turf. These vegetation types are generally distributed as mosaics, controlled by altitudinal zonation, modified by aspect and microclimate, and ultimately transformed by human impact. The vegetation is best developed between December and the end of March, leaving the remaining time of the year with a dry and brown composition.

The high altitude grasslands are usually dominated by the grasses *Merxmuellera disticha*, *Festuca caprina*, *Pentaschistis oreodoxa* and *Harpochloa falx*, or in moister places by the sedge *Scirpus falsus*. Ecological conditions and spatial distribution of these grasslands are likely to have been changed as a result of anthropo-zoogenic impacts over the last century. Species composition of the grassland vegetation, depending on the resilience to grazing and relative palatability of individual species, was probably also transformed. Subtropical *Themeda triandra* grasslands (Sesotho: *seboku*) are usually confined to the lower and warmer north-facing slopes below 3000 m. These grasslands are considered the economically most valuable pasture type. *Themeda triandra* is considered to decrease in abundance as grazing intensity increases (STAPLES a. HUDSON 1938, 13–16; MORRIS et al. 1989, 102).

Dwarf-scrub composed of *Helichrysum trilineatum*, *Erica dominans*, *Chrysocoma ciliata* and *Pentzia cooperi* colonizes heavily grazed slopes and valley bottoms. Especially *Chrysocoma ciliata* and *Pentzia cooperi* are considered to be strong invaders. These species, 'encroaching' from the lowlands of Lesotho, show a distinct increase

Photo 2: Typical grazing post (*motebo*) with small livestock in the upper Sanqebethu Valley. High pasturing is organized by individual shepherds, mostly young men, who live in the stone huts for extended periods. The roofs of these grazing posts are generally thatched with the foliage of the large tussock grass *Merxmuellera drakensbergensis*. Daily trailing of sheep and goats to and from this permanently used grazing post has led to accelerated soil erosion in close proximity to the *motebo*. Photograph taken from 2650 m (M. NÜSSER, 10.4.1999)

Typischer Weideposten (*motebo*) mit Kleintieren im oberen Sanqebethu-Tal. Die Hochweidenutzung wird von einzelnen Hirten, zumeist Jugendlichen organisiert, die über längere Zeiträume in den Hütten leben. Die Dächer dieser Weideposten werden generell mit dem Tussock-Gras *Merxmuellera drakensbergensis* gedeckt. In unmittelbarer Umgebung dieses ganzjährig genutzten Weidepostens zeigt sich verstärkte Bodenerosion infolge des täglichen Auf- und Abtriebs der Schaf- und Ziegenherden. Standort: 2650 m (10.4.1999)

in abundance with high grazing pressure (MORRIS et al. 1993, 49). Dwarf-scrub communities occupy large areas of eastern Lesotho. In this treeless environment, dwarf-scrubs constitute the only fuel wood supply for the shepherds at their grazing posts.

Sharply delimited and densely grown wetlands (Sesotho: *makhaobo*) and marshy grasslands of the upper catchments contrast vividly with the surrounding dry slopes. The wetlands[6] are rich in species and are considered important grazing grounds during the dry winter period. The low-growing wetland vegetation contains various grasses (*Agrostis lachnantha, A. subulifolia, Poa annua*) and sedges (*Scirpus falsus, S. ficinioides, Isolepis fluitans* and *Schoenoxiphium filiforme*) in variable quantities. Pools and silty depressions, often waterlogged in summer, form habitats for aquatic plant communities, with hygrophilous forbs (*Limosella inflata, Aponogeton ranunculiflorus, Crassula inanis, Ranunculus meyeri, Kniphofia caulescens, Moraea alticola*) and *Trifolium burchellianum* (VAN ZINDEREN BAKKER 1955, 417; KILLICK 1978b, 539; BACKÉUS a. GRAB 1995, 246). The wetland areas are often fringed by *Merxmuellera drakensbergensis* patches at water surplus sites. This less palatable tussock grass is frequently burnt, to obtain fresh green sprouts, which make a better fodder, especially for cattle. Burning of the tussocks is also considered a method of repelling jackals, which may predate sheep and goats. Besides, the foliage of *M. drakensbergensis* is also used for thatching of the grazing posts' roofs and for making ropes.

3 Transhumance patterns in eastern Lesotho: principles and evolution

Land use strategies of the Basotho people combine cropping and animal husbandry. Regular seasonal transhumance patterns between villages and mountain pastures are an integral element of the mixed agricultural system. Large flocks of sheep, goats, cattle and horses are kept in the high altitude grasslands during the summer grazing season between November and April. Scattered grazing posts (Sesotho: *motebo*)[7], with round stone huts and surrounding kraals, serve to house the shepherds and their small stock overnight (Photo 2).

[6] Hydrological functions, ecological aspects and degradation of Lesotho's wetlands, which act as sponges and secure perennial runoff, have been a major research issue over decades, e.g. VAN ZINDEREN BAKKER (1955); JACOT GUILLARMOD (1962; 1963; 1969); VAN ZINDEREN BAKKER a. WERGER (1974); GROBBELAAR a. STEGMANN (1987); HILLIARD a. BURTT (1987); BACKÉUS (1989); MEAKINS a. DUCKETT (1993); BACKÉUS a. GRAB (1995); MORRIS a. GRAB (1997); GRAB a. MORRIS (1999); SELBACH (2001).

[7] These grazing posts are mostly referred to as cattle posts in the literature but because of the large numbers of small stock (sheep and goats) kept in the summer grazing areas the term grazing post is preferred here.

Photo 3: The Koeneng Village (2530 m) forms the uppermost permanent settlement accessible for four-wheel drive vehicles in the Sanqebethu Valley. During wintertime the cultivated fields and the village environs are used as pastures. View towards West (M. NÜSSER, 13.8.1999)

Das Dorf Koeneng (2530 m) bildet die höchstgelegene, über eine Piste erschlossene Dauersiedlung im Sanqebethu-Tal. Während des Winters wird das Kulturland und die Dorfumgebung als Weidefläche genutzt. Blick nach Westen (13.8.1999)

The livestock grazes on the slopes in the vicinity of these *motebos*.

Summer grazing posts are usually located at altitudes between approximately 2750 and 3100 m. Although the high altitude grasslands are predominantly used for summer grazing, selected portions of these areas also serve as winter pastures, mainly for robust sheep and horses (STAPLES a. HUDSON 1938, 19; QUINLAN 1995, 503). In order to provide shelter in case of heavy snowfall, most winter grazing posts are located near to the uppermost villages, regularly below 2750 m so that livestock can be brought down quickly (QUINLAN a. MORRIS 1994, 78). As considerable portions of the subtropical *Themeda triandra* grasslands, especially on the more gentle slopes, have been transformed into cultivated fields and degradation of the remaining winter pastures in the village environs is widespread, stockholders are forced to use the high altitude grasslands on a permanent basis. Lack of sufficient winter forage is considered the major constraint for livestock keeping in the Lesotho highlands (Photo 3). Besides frequent animal losses due to deficient fodder resources, heavy snowfall and extended periods of drought, livestock keeping is confronted with high levels of stock theft and predatory jackals.

The altitudinal zonation and seasonal pattern of livestock keeping have evolved over the last century in response to increasing degradation of the lowlands and foothills (QUINLAN 1995, 492; NÜSSER 2001, 33). Rapid expansion of cultivated areas with scattered villages up to about 2700 m commenced simultaneously since the 1890s (STAPLES a. HUDSON 1938, 19). The development of land use evolved in parallel with distinct territorial utilization rights. Grazing areas in the vicinity of the villages were controlled by local chiefs and headmen, who imposed basic regulations to prevent free grazing of animals during the cropping season. Certain areas containing useful vegetation were set aside for the propagation of grass, thatch grass, and fuel wood. The need to conserve pastoral resources and livestock is based in indigenous law through the concept of *leboella*, which basically refers to restrictions of utilization in order to promote regeneration of natural vegetation and rotational usage (QUINLAN 1989, 25; WITZSCH 1992, 23). In contrast, temporal and spatial restrictions of utilization are rather limited and difficult to control in the remote mountain pastures. Grazing rights for the high altitude grassland have solely been issued by the Principal Chiefs as traditional leaders of the Basotho people, who had no reason to restrict pastoral utilization in these uninhabited areas. The lack of conceived territoriality over the mountain pastures has given rise to a transhumance system, which is based upon clan and kinship relations. Therefore, stockholders from different mountain villages and from the lowlands of Lesotho use the high pastures in common. Livestock ownership is further complicated by the traditional system of animal loans (Sesotho: *mafisa*), which is based on arrangements between stock owners and hired shepherds who care for the animals. Because of these

flexible arrangements, people can send their animals to the high pastures, even if their households have not sufficient workforce to cope with the demands of mobile livestock keeping.[8)]

The evolution of resource utilization and of the prevalent transhumance pattern is also marked by external interventions and innovations, which began during British colonial times. Prominent examples encompass anti-erosion schemes (SHOWERS 1989, 264; 1996, 655), the promotion of rotational grazing systems and destocking campaigns (PIM 1935, 140–143; STAPLES a. HUDSON 1938, 39–40). Traditionally, the Basotho livestock economy mainly concentrates on cattle breeding. Merino sheep and angora goats for wool and mohair production were introduced during colonial projects in the early 1900s, with a view of encouraging market-orientated livestock rearing (QUINLAN 1995, 493). The introduction of horses and donkeys as riding and pack animals, and selective breeding of the robust Basotho pony were necessary innovations to cope with increasing transport demands after the construction of bridle paths.

Post-colonial developments in pastoral resource utilization are strongly influenced by regulating interventions implemented by the state of Lesotho. Ongoing conflicts between the traditional leaders within the system of Chieftainship and elected Development Councils (since 1986) have led to unsolved problems of competence in adjudication of grazing rights (NÜSSER 2001, 34). Supported by international aid organizations, a number of development projects, which focus on livestock rearing and sustainable resource utilization have been established during the past 20 years. The objectives comprise a termination of seasonal transhumance between lowlands and mountains, inventories of grazing areas, livestock registration and grazing fees (MARTIN 1984, 32; PHORORO a. SIBOLLA 1999, 73). The intention was to replace the extensive subsistence economy with a commercial community-managed and state-regulated economy. The most substantial strategy to achieve these goals has been the introduction of Range Management Areas (RMA) for exclusive utilization rights of registered members of Grazing Associations (WEAVER 1991; ARTZ 1993; BUZZARD 1994).

Since 1988, the Sanqebethu Valley has been part of the Mokhotlong/Sanqebethu RMA and the Grazing Association was registered in 1991. To the present day the RMA programme is largely rejected by the Basotho and the Grazing Association is reported to have lacked the support of most chiefs from the beginning (HARTLEY 2001, 39). Recent efforts in environmental conservation concentrate on the implementation of a 'Transfrontier Conservation Area'. This area is designed to encompass the eastern Lesotho highlands together with the protected areas in the South African uKhahlamba Drakensberg Park, administered by the KwaZulu/Natal Nature Conservation Service. This area has recently (2000) been proclaimed a World Heritage Site.

4 Contemporary land use and land cover change in the Sanqebethu Valley

4.1 Development of pastoral utilization

Animal numbers and corresponding livestock units (Tab. 1), resulting stocking densities (Tab. 2), and the numbers of grazing posts (Tab. 3) are used as indicators to quantify recent development of pastoral utilization in the Jareteng, Langa-le-balele and Merareng Valleys. Although the grazing posts are also mapped in the Mahlabachana, Moiteling and upper Mokhotlong Valleys (Fig. 2 – Suppl. III), comparative analyses are not possible in these areas due to the lack of quantitative data from the late 1980s.

Moreover, seasonal differences and spatial aspects of grazing post utilization have to be taken into consideration, as these factors contribute significantly to uneven grazing intensity. In sheltered positions, especially in the vicinity of junctions with the tributaries of the Sanqebethu River one can find a number of grazing posts that are used throughout the year. These permanently used grazing posts are located below 2750 m, so that the uppermost villages can be reached within three to four hours in case of snow hazards. On the other hand, the harsh climatic conditions in the immediate proximity of the escarpment form a major constraint for utilization. Therefore, the density of grazing posts is lower and the number of abandoned and deserted stock outposts is higher in the uppermost tributaries than in the lower lying valley sections (Fig. 2 – Suppl. III). Abandonment of grazing posts can result for multiple reasons. These reasons comprise inter-annual variations in utilization due to changes in *mafisa* arrangements, insufficient pasture and fuel wood resources, and the extent of burning and the resulting lack of tussock grasses necessary for roof thatching of the *motebos*.

The figures from 1988 and 1999 show a remarkable and in some cases an extreme decrease in the intensity

[8)] Widespread pooling of herds and delegation of livestock grazing activities appear to be consequences of Lesotho's traditional labour migration system, characterized by the absence of male workforce, who take non-agrarian income opportunities in South Africa, mainly in the gold mines.

Table 1: Animal numbers and livestock units (LU) in the upper tributaries of the Sanqebethu Valley, 1988 and 1999
Tierzahlen und Tiereinheiten (LU) in den oberen Tributären des Sanqebethu-Tales, 1988 und 1999

Tributary valley / grazing area		Sheep		Goats		Cattle		Horses		Donkeys		Totals	
	Season	1988	1999	1988	1999	1988	1999	1988	1999	1988	1999	1988	1999
Jareteng													
Animal numbers	summer	2530	1256	1419	722	291	157	91	91	27	32		
	winter	770	180	66	88	0	71	6	5	0	0		
Livestock units	summer	506.0	251.2	283.8	144.4	232.8	125.6	63.7	63.7	13.5	16.0	1099.8	600.9
	winter	154.0	36.0	13.2	17.6	0	56.8	4.2	3.5	0	0	171.4	113.9
Langa-le-balele													
Animal numbers	summer	1037	999	879	467	198	116	49	20	21	21		
	winter	133	0	0	0	0	0	0	0	0	0		
Livestock units	summer	207.4	199.8	175.8	93.4	158.4	92.8	34.3	14.0	10.5	10.5	586.4	410.5
	Winter	26.6	0	0	0	0	0	0	0	0	0	26.6	0
Merareng													
Animal numbers	summer	1401	1597	903	622	132	79	56	72	16	33		
	winter	691	721	23	115	0	26	9	21	0	19		
Livestock units	summer	280.2	319.4	180.6	124.4	105.6	63.2	39.2	50.4	8.0	16.5	613.6	573.9
	winter	138.2	144.2	4.6	23.0	0	20.8	6.3	14.7	0	9.5	149.1	212.2

Animal unit conversion according to Range Management Division (1990): sheep: 0.2, goat: 0.2, cattle: 0.8, horse: 0.7, donkey: 0.5
Data for 1988: QUINLAN (1989); QUINLAN a. MORRIS (1994); data for 1999: author's own surveys and calculations

of high pasture utilization. The decrease in livestock units and resulting stocking densities is more pronounced in the Jareteng and Langa-le-balele Valleys and in the case of sheep and goats in both summer and winter grazing areas. Only the pastures of the Merareng Valley, situated in close proximity to the uppermost permanent settlements, show a slight increase in the intensity of utilization, especially in the case of winter grazing. These results are supported by the numbers and seasonal utilization of *motebos* (Fig. 2 – Suppl. III). Whereas the totals of summer grazing posts have decreased in all valleys between 1988 and 1999, the numbers of permanently used grazing posts do not vary to any great extent (Tab. 3). Only the figures from the Merareng Valley show a slight increase in permanent grazing posts. Interviews with the shepherds in the Jareteng and Langa-le-balele Valleys revealed that the intensity of winter use decreased in these upper tributaries after the snow disaster occurring in 1996. This hazardous event resulted in a snow cover, which lasted for more than three months on the summits of the Drakensberg escarpment.

4.2 Land cover change

In order to correlate the results of the comparative analyses of pastoral utilization intensity with corresponding land cover change, multi-temporal satellite data (Landsat 5 TM imagery, 169/80) from the end of the vegetation period in March 1989 and March 1999 were assumed to be a suitable data source for change detection.[9] Both images (9.3.1989 and 5.3.1999) show similar atmospheric conditions. Precipitation data from Underberg (Station Shaleburn, 1613 m, 29°48' S, 29°21'E) in South Africa, situated c. 60 km to the south of Sanqebethu Valley at the foot of the escarpment, in-

Table 2: Stocking densities (SD) in the upper tributaries of the Sanqebethu Valley, 1988 and 1999
Bestockungsdichten (SD) in den oberen Tributären des Sanqebethu-Tales, 1988 und 1999

	Jareteng	Langa-le-balele	Merareng	Total
Tributary valley/grazing area [ha]	2306	1321	2387	6014
Stocking densities [LU/ha]				
Summer 1988	0.48	0.44	0.26	0.38
Summer 1999	0.26	0.31	0.24	0.26
Winter 1988	0.07	0.02	0.06	0.06
Winter 1999	0.05	0	0.09	0.05

Data for 1988: QUINLAN (1989); QUINLAN a. MORRIS (1994); data for 1999: author's own surveys and calculations

Table 3: Number of grazing posts and intensity of utilization
Anzahl und Nutzungsintensität der Weideposten

	Jareteng		Langa-le-balele		Merareng	
Year	1988	1999	1988	1999	1988	1999
utilization during summer	20	14	14	10	7	5
utilization permanently	6	4	1	1	5	6
abandoned, deserted	3	13	no data	11	no data	7

Data for 1988: QUINLAN (1989); QUINLAN a. MORRIS (1994); data for 1999: author's own surveys and calculations

dicate that the vegetation period 1988/89 received considerably higher amounts of precipitation than the respective period 1998/99 (October 1988 – March 1989: 939.6 mm; October 1998 – March 1999: 787.2 mm).[10] Varying humidity during the two growing seasons may result in phenological differences, but visual interpretation shows slight variation only.

The differences between the satellite images from March 1989 and 1999 become more obvious, after calculating *Normalized Difference Vegetation Indices* (NDVI).[11] A certain decrease in vegetation cover and corresponding pasture phytomass can be detected, especially in places of grazing post concentrations and more accessible areas, e.g. in the Sanqebethu Valley and in the lower portions of the Jareteng and Langa-le-balele Valleys. On the other hand, the large wetlands in the remote upper sections of the Merareng and Mokhotlong Valleys do not show detectable changes (Fig. 4).

The results from interpretation of remote sensing data are supported by recent field surveys and vegetation transects.[12] According to these data, the slopes of the Sanqebethu Valley between approximately 2700 and 2980 m reveal poor range conditions with high proportions of *Chrysocoma ciliata* and *Pentzia cooperi*. The open grasslands between basalt outcrops are generally characterized by heavy grazing with high intensity of winter grazing and single stands of burnt *Merxmuellera drakensbergensis* patches. Also the predominantly north-facing transects from the Jareteng and Langa-le-balele Valleys (2750–3150 m) show poor to fair range conditions. Obviously these areas are heavily grazed, especially in the vicinity of grazing post concentrations near the river junctions.

Poor range conditions, discernible erosion and turf loss in the lower valley sections must be regarded as consequences of permanent grazing pressure throughout the year. In contrast, in some of the higher tributaries range conditions are more positive (Photo 4). The harsh climatic conditions in these upper valley heads present a major constraint to herders and livestock and the grasslands in close proximity of the escarpment can be described as 'additional' summer pastures. The same holds true for the above mentioned wetlands in the upper sections of the Merareng and Mokhotlong Valleys.

5 Discussion and conclusions

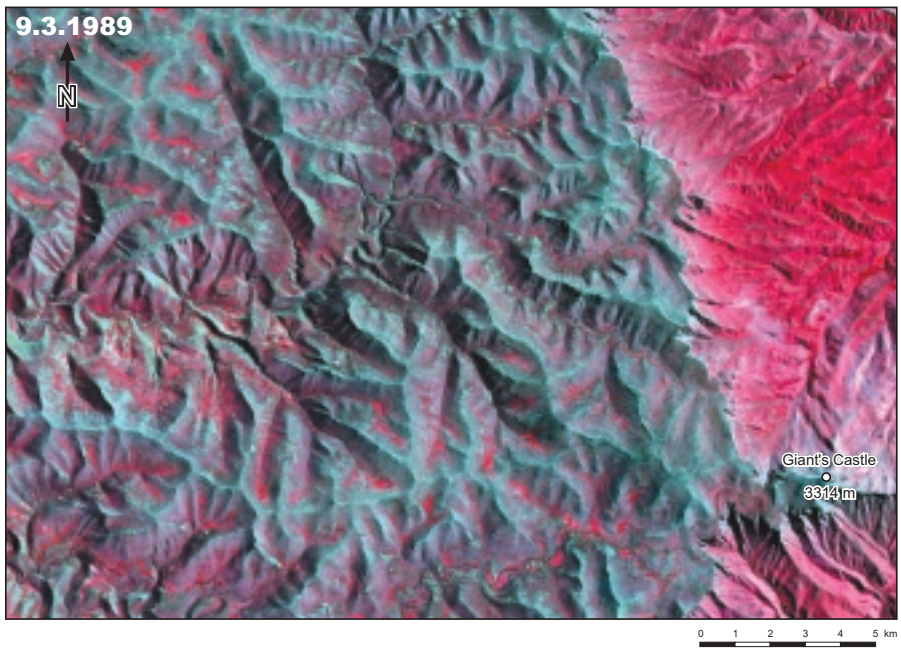
The study area is part of a mountain environment that has been transformed by pastoral utilization during the past century. Research findings from the late 1980s (QUINLAN 1989, 67; MORRIS et al. 1989, 84–85) show an exponential increase in grazing post numbers between the 1930s and the late 1980s. The rapid expansion of pastoral utilization in the upper ecological belt is further reinforced by the tendency to extend the grazing period in the high altitude grasslands due to degradation of winter pastures in the village environs (QUINLAN a. MORRIS 1994, 78; QUINLAN 1995, 503). Apparently, these findings correspond to the typical developmental scenario for Lesotho. However, the assessment of recent land use change between 1988 and 1999 presented here provides evidence for a con-

[9] Standardized operations of digital image processing have been carried out to obtain a database for comparative visual and digital interpretation.

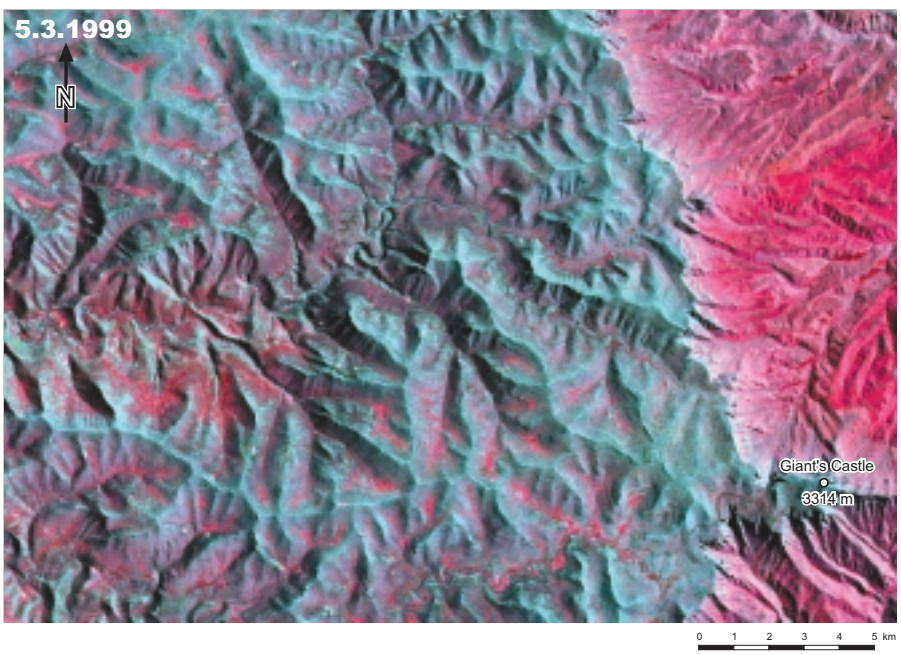
[10] These data were kindly provided by S. Grab (University of the Witwatersrand, Johannesburg). Corresponding rainfall data from the study area are not available.

[11] Landsat TM bands 4 (Near Infrared, NIR) and 3 (Red) of corresponding subsets have been used to calculate this standard vegetation index according to the algorithm NDVI = (NIR-Red)/(NIR+Red). This transformation of multispectral data into a single image band indicates the amount of green phytomass present in each pixel and represents vegetation distribution.

[12] The vegetation transects were carried out using the metric belt transect method, which is used to determine cover, species composition, relative species abundance and phytomass production. This method uses a double-sampling technique to convert crown cover measurements for the species to total standing phytomass by species and, thereafter, for the transect (SCHMUTZ et al. 1982; MORRIS et al. 1989).



a)

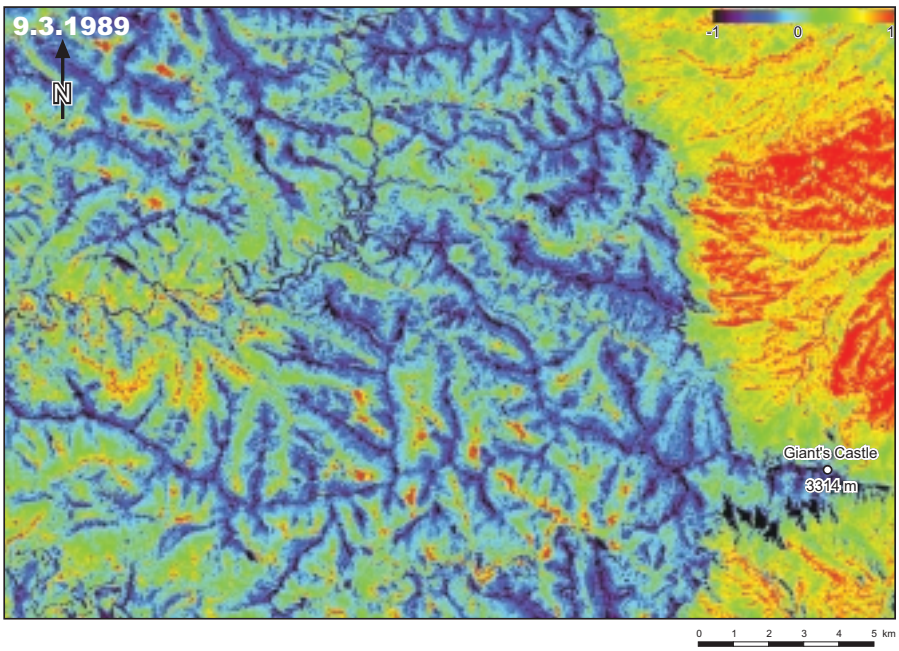


b)

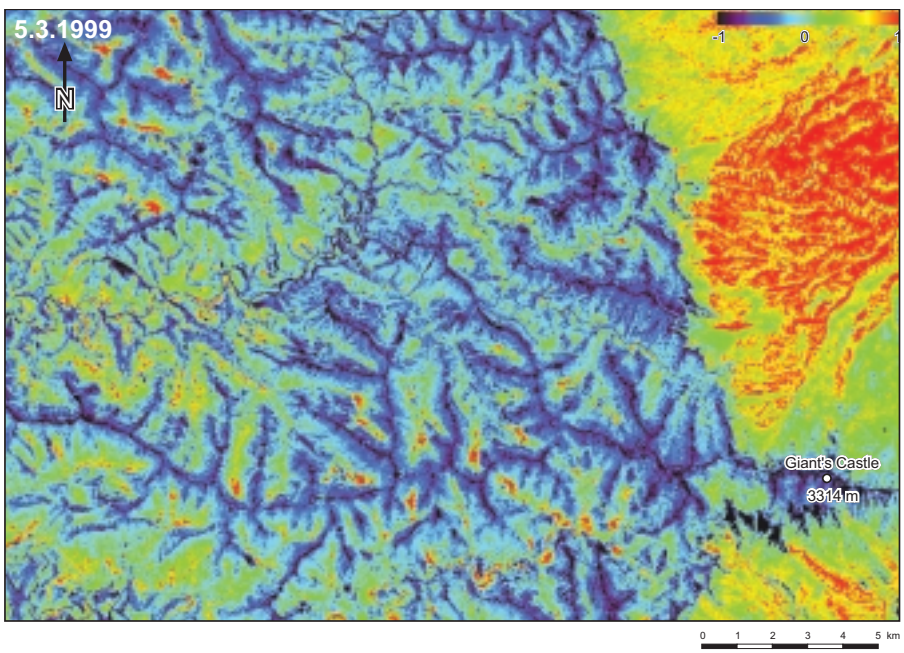
Fig.3: Geo-referenced subsets of Landsat TM imagery (169/80) showing the upper Sanqebethu Valley, colour composites, 4,3,2 = RGB, (a) 9.3.1989 and (b) 5.3.1999

Georeferenzierte Ausschnitte von Landsat TM-Bildern (169/80) des oberen Sanqebethu-Tales, Farbkompositen, 4,3,2 = RGB, (a) 9.3.1989 und (b) 5.3.1999

trasting trend, characterized by a conspicuous decrease in the intensity of high pasture utilization. As annual data of utilization intensity and continuous time series of animal numbers are not available, interpretation of change over the interim decade is based on the two years of observation only. The explanation of contemporary land use and land cover change between the late 1980s and the late 1990s needs to incorporate multifactorial causes. These principal components of pastoral development include climatic impacts such as rain-



a)



b)

Fig.4: NDVI calculations of geo-referenced Landsat TM imagery showing the upper Sanqebethu Valley, (a) 9.3.1989 and (b) 5.3.1999

Aus den georeferenzierten Landsat-Daten berechnete Vegetationsindices (NDVI) des oberen Sanqebethu-Tales, (a) 9.3.1989 und (b) 5.3.1999

fall variability and natural hazards, exogenous factors such as market-orientated incentives and constraints, and responding changes in livelihood strategies (Fig. 5).

Apparently, inter-annual rainfall variability and natural hazards cause significant modifications in the intensity of pastoral utilization. However, the marked decrease in pastoral utilization between 1988 and 1999 cannot be satisfactorily explained as a consequence of livestock losses after the snowfall during July 1996, because the data for 1988 also reflect the preceding snow

Photo 4: Positive range conditions can be found in remote areas of the higher tributaries in close proximity to the escarpment, Mohlesi Valley, 2940 m, view towards Southeast (M. NÜSSER, 16.4.1999)

In abgelegenen Bereichen der oberen Tributäre, insbesondere am Rand des Escarpments lassen sich günstige Weidebedingungen erkennen. Beispiel aus dem Mohlesi-Tal, 2940 m. Blick nach Südwesten (16.4.1999)

hazard from late September 1987. The recent decrease in small stock populations can only be explained by exogenous factors such as falling prices and unpopular marketing arrangements for wool and mohair (PHORORO a. SIBOLLA 1999, 62).

Despite the significant reduction in high pasture utilization, the comparative analysis of satellite imagery reveals a slight decrease in vegetation cover of the high altitude grasslands over the interim decade. It remains uncertain to what extent land cover change results from continuous (although reduced) grazing pressure or from differences in precipitation between 1989 and 1999. However, the detectable pattern of grassland degradation in the vicinity of permanent grazing posts indicates continued over-use throughout the year. Evidently, the high intensity of winter and early spring grazing primarily accounts for the observed degradation of pastures in the lower valley sections.

The high altitude grasslands of Lesotho are managed under a common property regime and the grazing system follows a utilization strategy, which is typical for non-equilibrium environments. As the livestock economy is prone to natural hazards and high levels of rainfall variability, mobility and flexibility are considered key components of regional livelihood strategies under the prevailing conditions of uncertainty.

Grazing issues in Lesotho are typically presented as a 'tragedy of the commons' scenario together with conventional policy solutions of increased state control over the pastoral resources or privatization of rangelands (MAJORO 1999, 15). The most substantial Government intervention to address grazing issues has been the introduction of the Range Management Areas Programme. As this programme questions the legitimacy of the traditional transhumance pattern and proposes reductions in stock numbers aligned to ecological carrying capacities, it has largely been rejected by the local Basotho population. Without recognizing the principles, necessities, shortcomings and possible alternatives of the current transhumance pattern, any effort to reduce animal numbers in the high altitude grasslands will definitely lead to overstocking and further degradation of lower lying winter pastures in the vicinity of the permanent settlements. A participatory approach and a recognition of existing rules and regulations in the management of common property regimes are essential requirements for effective planning of pastoral resource management. Recent concepts on managing common pool resources (e.g. OSTROM 1990; HANNA et al. 1995; BERKES a. FOLKE 1998) strengthen the idea that the existing institutions within natural resource management systems may provide a more appropriate basis to develop a functioning commons. Whether or not the continual dilemma between the traditional grazing system and the prevailing environmental degradation in Lesotho can be resolved by external interventions remains an open question.

Acknowledgements

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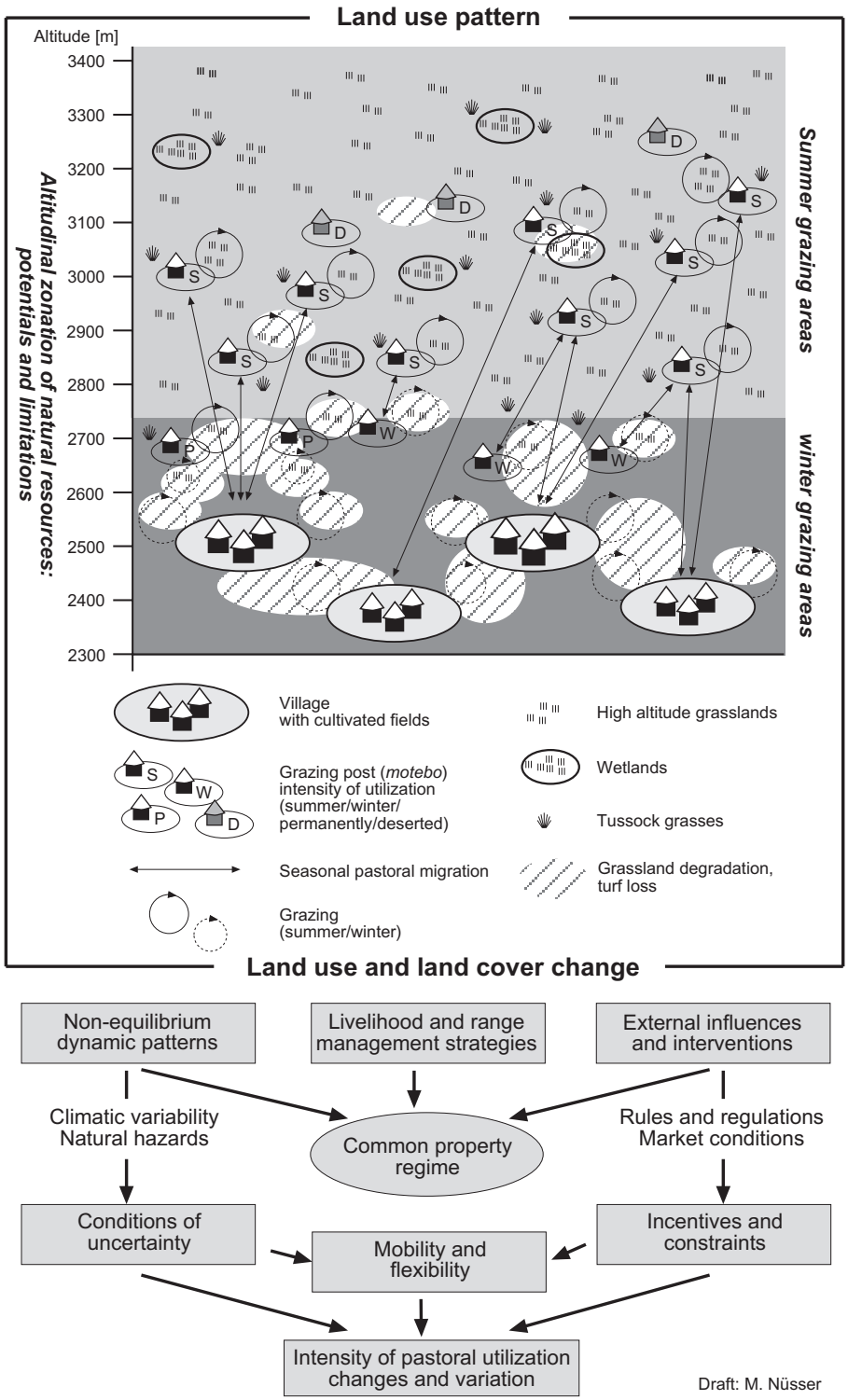

Fig.5: Principal components of pastoral resource utilization patterns and impact factors of corresponding land cover change in eastern Lesotho

Hauptkomponenten der weidewirtschaftlichen Ressourcennutzungsmuster und Einflussfaktoren auf den Landschaftswandel im östlichen Lesotho

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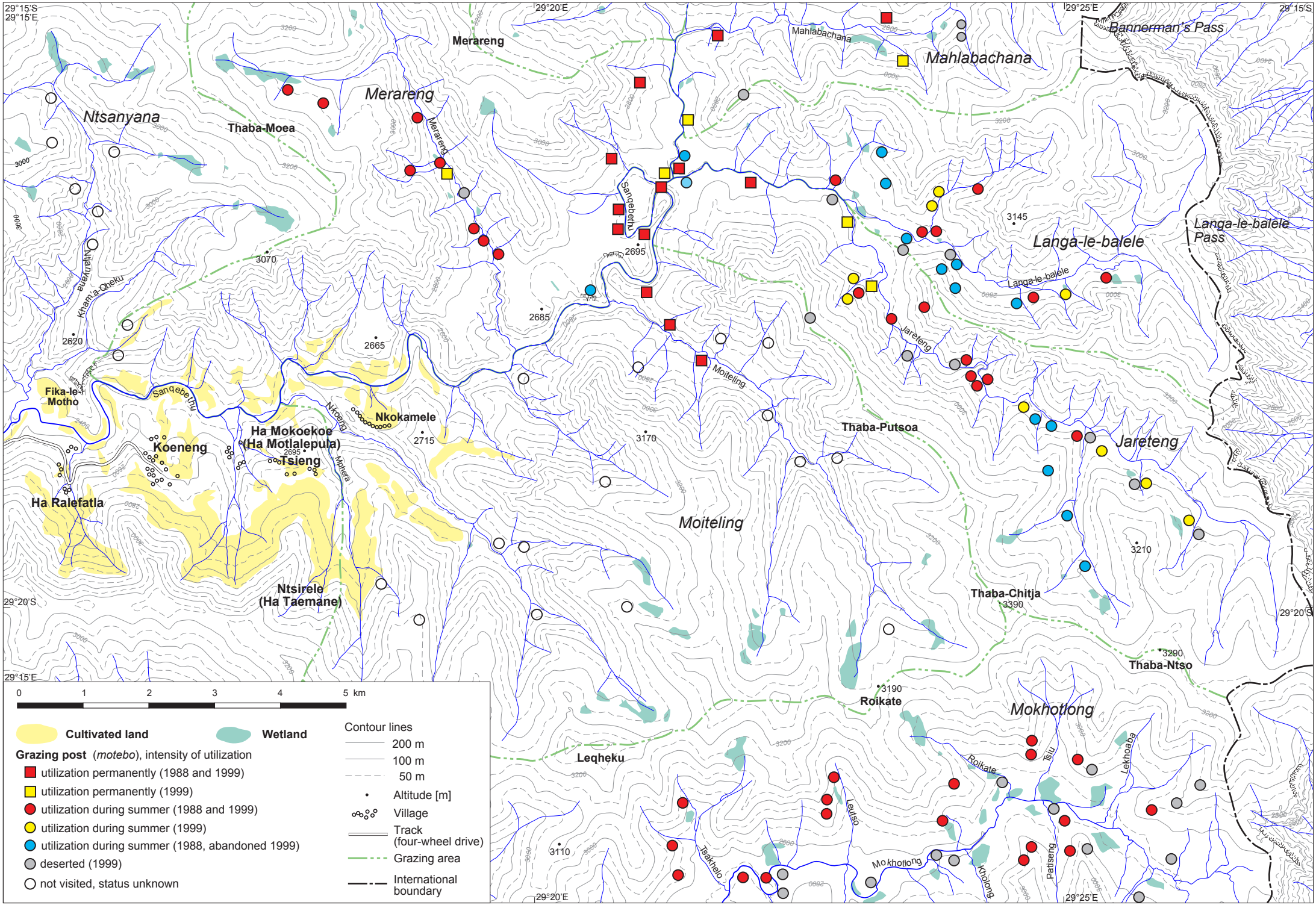
Fig. 2 **Map of Sanqebethu Valley**



Sources: Lesotho 1:50 000, sheet 2929 AD (39):Thabana Ntlenyana, 1982; Landsat TM data (169/80), 5.3.1999; Field surveys by T. Quinlan 1988 and M. Nüsser 1999

Draft: M. Nüsser; Cartography: G. Bräuer-Jux, M. Nüsser